

--36. The piezoelectric device according to claim 34, wherein an underfill material permeates the gap and fills a portion of the integrated circuit having the plurality of bumps.--

--37. The piezoelectric device according to claim 1, wherein an underfill material permeates to the first layer and fills a portion of the integrated circuit having the plurality of bumps.--

#### REMARKS

Claims 1-5, 7-24 and 26-37 are pending herein, with claims 31 and 32 being withdrawn from consideration by way of a prior Restriction Requirement. By this Amendment, claims 33-37 have been added. Support for new claims 33-36 may be found in the specification at, for example, paragraphs [0095] to [0101]. Support for new claim 37 may be found in the specification at, for example, paragraphs [0088] and [0089].

In view of the foregoing amendments and the following remarks, reconsideration of this application is respectfully requested.

Applicant appreciates the courtesies shown to Applicant's representative by Examiner Budd in the February 11, 2003 personal interview. Applicant's separate record of the substance of the interview is incorporated into the following remarks.

#### **I. REJECTIONS UNDER 35 U.S.C. §103(a)**

##### **A. CLAIMS 1-5, 7-9, 22-24 AND 26-30**

Claims 1-5, 7-9, 22-24 and 26-30 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Patent No. 5,949,294 (hereinafter "Kondo") in view of JP 04-18732 (JP 732), JP 08-264540 (JP 540) or JP 08-222606 (JP 606). This rejection is respectfully traversed.

##### **1. Claim 1 and Claims Dependent Therefrom**

Claim 1 recites a piezoelectric device comprising a semiconductor integrated circuit having a plurality of bumps formed thereon; and a piezoelectric resonator element. The

semiconductor integrated circuit and the piezoelectric resonator element are included in a package. Further, the semiconductor integrated circuit is mounted in a center of an opening formed in a center of a base, the semiconductor integrated circuit being connected to an input/output electrode pattern on the base through the plurality of bumps. The base includes a layered part, which surrounds the semiconductor integrated circuit, for mounting the piezoelectric resonator element, the layered part comprising at least two layers, including a first layer and a second layer, the first layer being below the second layer, and an opening of the first layer formed to be larger than an opening of the second layer.

In the Office Action, it was alleged that Kondo illustrated in Fig. 5 the structure required of the base as recited in claim 1. In particular, the Office Action identified the outer peripheral wall 8 of the second container 5 as an upper or second layer, and outer peripheral wall 4 of the first container 1 as a lower or first layer having an opening larger than the opening of the second layer. Applicant respectfully submits that the characterization of the teachings of Kondo are not correct, and that Kondo does not teach or suggest the structure of the base of the claimed piezoelectric device.

Kondo describes an oscillator formed from first and second containers, the first container including an integrated circuit active element 2 mounted therein and electrically connected to electrodes via wire bonding 12. A second, separate container 5 is attached onto an opening of the first container 1 so that electrodes of the respective containers are connected. By using separate containers, it is described that a damaged part may be easily removed and replaced without having to dispose of the entire unit. See the Abstract.

As shown in Fig. 5, outer peripheral wall 8, cited in the Office Action as allegedly corresponding to the second layer of the base of the piezoelectric device of claim 1 of the present application, is a part of the second container 5 that houses the oscillating element 6, which container is above and separate from the first container 1 housing the active element 2.

This outer peripheral wall 8 is in a container above and separate from the first container 1 housing the active element 2 and is in fact separated from the first container by the base layer of the second container that seals the first container (see col. 3, lines 34-43 of Kondo). Thus, it is clear that the wall 8 in Fig. 5 of Kondo does not correspond to the second layer of the base of the piezoelectric device defined in present claim 1.

Specifically, layer 8 of the second container of Fig. 5 of Kondo is not a part of a layered part which surrounds the semiconductor integrated circuit in the device of Kondo. Wall 8 in Fig. 5 of Kondo is above and completely separate from the active element 2, and thus does not surround such active element at all. In this regard, the Patent Office is directed to Fig. 9 in the present application, wherein the layered part 5 comprises a second layer 25 and a first layer 24 that surround the semiconductor integrated circuit.

Further, wall 4 of the first container in the device of Fig. 5 of Kondo, although surrounding the integrated circuit, does not form any part of a structure for mounting the piezoelectric resonator element. Instead in Kondo, the oscillating element 6 is mounted in a completely separate container placed atop wall 4 of the first container. Moreover, wall 4 does not include a lower wall that has an opening that is larger than an upper wall.

Finally, as explained in paragraph [0089] of the present specification, the employment of the base structure defined in present claim 1 permits the underfill material 23 to properly permeate to the bonded portion of the bumps 4 so that a highly reliable bonding structure is obtained as illustrated in Fig. 9. As wall 8 in Fig. 5 of Kondo is in a completely separate container, and is separated by a base layer of the second container from the first container housing the active element 2, layer 8 clearly cannot participate at all in assisting permeation of an underfill material about the active element 2.

In fact, Kondo teaches that the design including two separate containers set forth therein permits elimination of the need for a resin molding on the outer periphery of the

active element 2. See col. 3, lines 44-46. Thus, nothing in Kondo would have led one of ordinary skill in the art to the base structure of the piezoelectric device recited in present claim 1.

None of JP 732, JP 540 or JP 606 remedy the deficiencies of Kondo discussed above. The Patent Office again relies upon the secondary Japanese references as allegedly suggesting that the use of flip-chip bump connections for coupling an integrated circuit chip to a base was well known. However, none of these references teach or suggest a device as recited in claim 1 in which the base includes a layered part, surrounding a semiconductor integrated circuit, and in which the lower layered part has an opening larger than the upper layered part. Thus, even if the teachings of the references were to have been combined as in the Office Action, the combined teachings still would not have led one of ordinary skill in the art to the presently claimed invention.

For at least the foregoing reasons, Applicant respectfully submits that none of Kondo JP 732, JP 540 or JP 606, whether taken singly or in combination, would have led one of one of ordinary skill in the art to the presently claimed invention.

**2. Claim 22 and Claims Dependent Therefrom**

Claim 22 recites a piezoelectric device that comprises a semiconductor integrated circuit and a piezoelectric resonator element, the semiconductor integrated circuit and the piezoelectric resonator element being included in a package. Further, claim 22 requires that each of a plurality of bumps formed on a semiconductor integrated circuit be shaped to have two levels, a first level having a diameter of 0.8 to 0.9 times, and a second level having a diameter 0.4 to 0.45 times, the length of an opening in a pad provided on the active element surface of the semiconductor integrated circuit.

The Patent Office has acknowledged that none of the cited references teach or suggest a device having this recited feature. Nevertheless, the Patent Office concludes that such a

device would have been obvious to one of ordinary skill in the art as derivable through routine trial and error. Applicant respectfully submits that the Patent Office has failed to establish a *prima facie* case of obviousness. Specifically, the Patent Office has acknowledged that a recited limitation is absent from the cited art, yet nevertheless concludes, without any basis in the art for doing so, that the limitation would have been obvious as derivable by trial and error.

For a limitation to be properly found obvious on the basis of routine optimization, it is necessary for the prior art to provide some guidance and/or suggestion as to the variable required to be optimized, that is, the prior art must provide some reason that one of ordinary skill in the art would even explore varying the variable in the first place. Here, no such basis is provided in the cited art at all. Thus, nothing in the cited art would have led one of ordinary skill in the art to look to the relationship among the dimensions of the layers of a bump as in the invention recited in claim 22 at all. Much less would such teachings have directed one to adjust that relationship and thus possibly arrived at the relationship recited in claim 22.

The only one of the cited references even mentioning layered bumps is JP 540. While JP 540 describes a bump structure comprising two layers, JP 540 does not teach or suggest the dimensions recited in claim 22 for the layers, nor any basis for adjusting the dimension of layers with respect to each other and the length of an opening in a pad for any reason whatsoever.

For the foregoing reasons, Applicant respectfully submits that none of Kondo, JP 732, JP 540 or JP 606 teach or suggest the embodiment recited in present claim 22.

### 3. Conclusion

For all the foregoing reasons, Applicant respectfully submits that Kondo, JP 732, JP 540 or JP 606, whether taken singly or in any combination, would not have rendered

obvious the invention recited in claims 1-5, 7-9, 22-24 and 26-30. Reconsideration and withdrawal of this rejection are thus respectfully requested.

**B. CLAIMS 10-21**

Claims 10-21 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Kondo in view of JP 732, JP 540 or JP 606, further in view of U.S. Patent No. 4,684,843 (hereinafter "Ohya")<sup>1</sup>. This rejection is respectfully traversed.

Regarding independent claim 10 and claims dependent therefrom, and independent claim 14 and claims dependent therefrom, these claims require a piezoelectric device in which the base for mounting the semiconductor integrated circuit includes a protrusion formed in at least one side wall of the base facing the side of the semiconductor integrated circuit and protruding into the opening to form the protrusion.

As recognized in the Office Action, none of Kondo, JP 732, JP 540 or JP 606 teach or suggest such a piezoelectric device. However, the Patent Office turned to the teachings of Ohya as allegedly suggesting such protrusions in the side wall of a base for mounting a semiconductor integrated circuit. Applicant respectfully disagrees.

Ohya describes a piezo-resonator in which resonator 1 is mechanically supported within the aperture of an insulating frame 4, which insulating frame includes small protrusions 4b that may be brought into mating engagement with the peripheral sides of the resonator. See col. 2, lines 24-28 of Ohya. Ohya would not have remedied the deficiencies of Kondo JP 732, JP 540 and JP 606 for several reasons.

First, Ohya describes an insulating frame for mounting a resonator therein, and provides no teachings or suggestions at all concerning the structure to be used for a base for

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<sup>1</sup> Although the statement of the rejection in the Office Action refers only to Ohya, the text of the rejection also refers to Inoi and Knecht. It is believed that the mention of Inoi and Knecht in the discussion of the rejection is erroneous and was carried forward from a similar prior statement of the rejection in previous Office Actions. Applicant herein addresses the teachings Ohya as the reference intended to be relied upon in the Office Action.

mounting a semiconductor integrated circuit therein as in the invention of claims 10-21. At best then, Ohya might have led one of ordinary skill in the art to include the mating protrusions in the second container 5 in the device of Fig. 5 of Kondo. However, nothing in Ohya would have led one of ordinary skill in the art to have used such mating projections of a side wall to hold a semiconductor integrated circuit.

Second, the Patent Office speculates that the projections are used in Ohya to help orient the electronic component during mounting or to keep the component from contacting the side wall. However, no such teaching or suggestion concerning the use of the protrusions in Ohya is found in Ohya itself. Rather, it appears from Ohya that the protrusions are used as an alternative mounting means for mounting the resonator in the frame, and does not utilize the protrusions for orientation or to prevent contact with a side wall as erroneously alleged in the Office Action.

Third, it must be emphasized as described in the present specification and illustrated in Figs. 10 and 11 that the protrusions from the side wall of the base in which the semiconductor integrated circuit is mounted is used in assisting the underfill material 23 in completely filling the portion of the integrated circuit chip in which the bumps are provided. The protrusions ease the surface tension, thereby permitting the underfill material to permeate the gap between the integrated circuit chip and the protrusions, and thus completely fill the portion of the integrated circuit chip provided with the bumps. See, for example, paragraphs [0095] to [0101], and Figures 10(a), 10(b) and 11(a), of the present application.

Finally, new claims 33 and 34 make explicit the fact that there is a gap between the protrusion and the semiconductor integrated circuit. Ohya requires engagement contact between the protrusions and the resonator, and thus fails to teach or suggest this feature, and in fact teaches against this feature.

New claims 35 and 36 further add that the piezoelectric device further includes an underfill material in and around the portion of the integrated circuit chip provided with the bumps. None of the references teach or suggest the overall structure recited in claims 35 and 36. As explained in paragraph [0101], the underfill material, which is aided by the protrusions in filling the portion with the bumps as discussed above, not only enhances the reliability of the bond, but also serves to radiate heat from the integrated circuit. The references do not teach or suggest such structure and operation.

In view of the foregoing significant distinctions, it is evident that nothing in Ohya would have led one of ordinary skill in the art to have modified the teachings of Kondo so as to have included protrusions from a side wall of the base in which the semiconductor integrated circuit is mounted. Thus, for at least the foregoing reasons, Applicant respectfully requests reconsideration and withdrawal of this rejection.

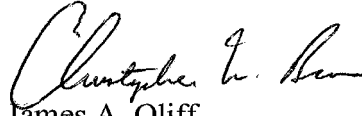
## **II. Conclusion**

In view of the foregoing amendments and remarks, Applicant submits that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 1-5, 7-24 and 26-34 are earnestly solicited.



Should the Examiner believe that anything further would be desirable in order to place this application in better condition for allowance, the Examiner is invited to contact Applicant's undersigned representative at the telephone number set forth below.

Respectfully submitted,



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